

The Steubenville Comprehensive Air Monitoring Project (SCAMP)

Sponsored by ...



The DOE-NETL Fine Particulate Matter (PM_{2.5}) Research Program

*U.S. Department of Energy
Office of Fossil Energy
National Energy Technology
Laboratory*



SCAMP - Project Overview

- **Outdoor (Ambient) Study**

- Central monitoring site; four satellite sites
- Primary performer: CONSOL, Inc.
- Daily sampling of ambient $PM_{2.5}$ for 2-yr period
- Funding: DOE, EPA

- **Personal Exposure Study**

- Outdoor vs. indoor vs. personal $PM_{2.5}$ in Steubenville
- Primary Performer: Harvard School of Public Health
- Primary Funding: Ohio Coal Development Office (OCDO)
- Co-funding: EPRI, NMA, API, AISI, CONSOL



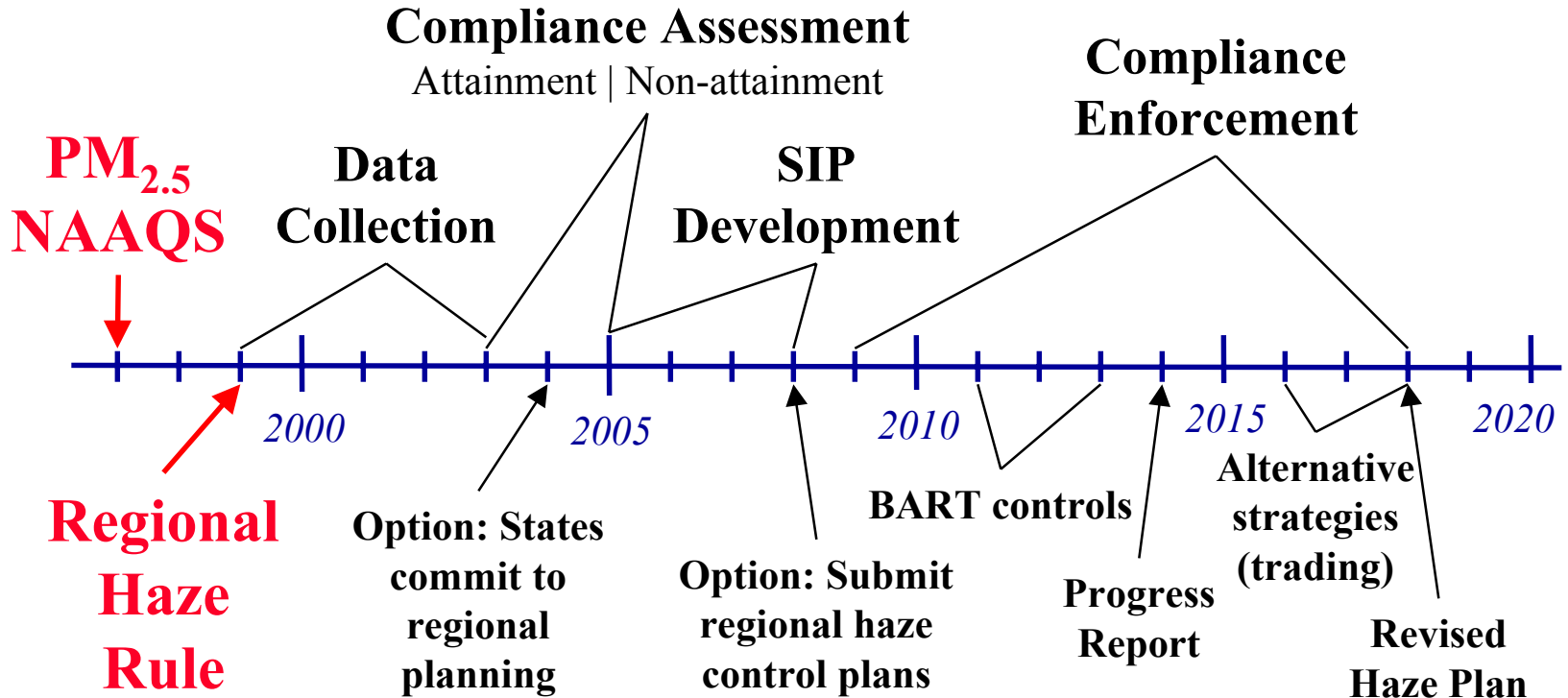
What is PM_{2.5}?

- “PM_x”= Airborne particles having a mean aerodynamic diameter of “x” μm or smaller
- **Primary**: formed and emitted as solid particles
 - soil and rock abrasion; sea salt; pollen and mold spores; fly ash; diesel soot
- **Secondary**: reaction of gaseous precursors in the atmosphere to form solid particles
 - $2\text{NH}_3 + \text{SO}_2 + \text{H}_2\text{O} + \frac{1}{2}\text{O}_2 \rightarrow (\text{NH}_4)_2\text{SO}_4$
- **Major Sources**:
 - PM₁₀ - Mechanical generation; primary
 - PM_{2.5} - Combustion; secondary

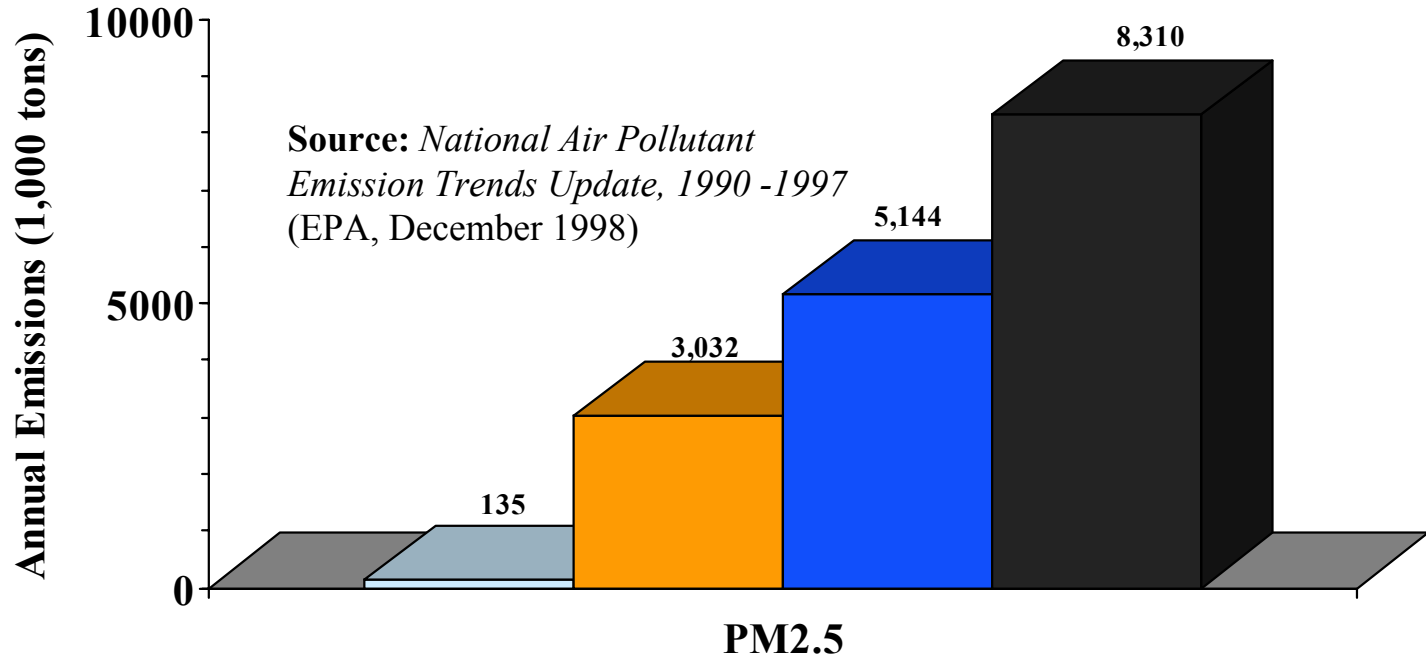
Regulatory Drivers

- **1997 National Ambient Air Quality Standards (NAAQS) for PM_{2.5}**
 - Added to pre-existing standards for PM₁₀
 - Based on adverse health effects
 - Annual avg. < 15 µg/m³; Daily max. < 65µg/ m³
- **1999 Regional Haze Rule**
 - PM_{2.5} reduces long-range visibility
 - Rule targets 156 “Class I” areas (parks, wilderness)
 - All 50 states involved in planning process
 - Goal: “natural” conditions in 60 years
 - Implementation parallels PM_{2.5} NAAQS

Regulatory Timelines

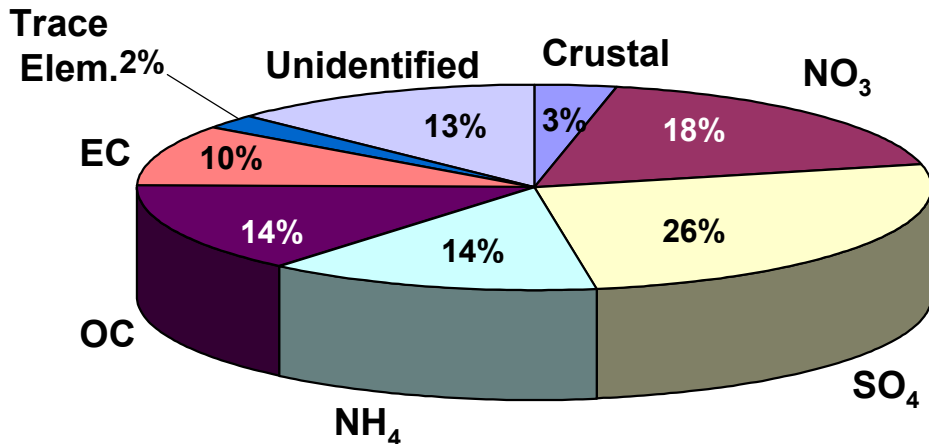


1997 U.S. Primary PM_{2.5} Emissions

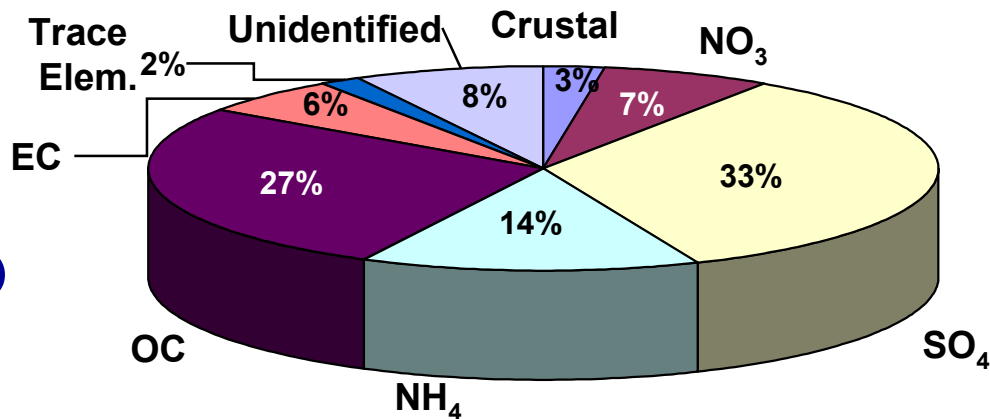


□ Coal plants □ Other Indust. & Transp. □ Fugitive dust, fires ■ All sources

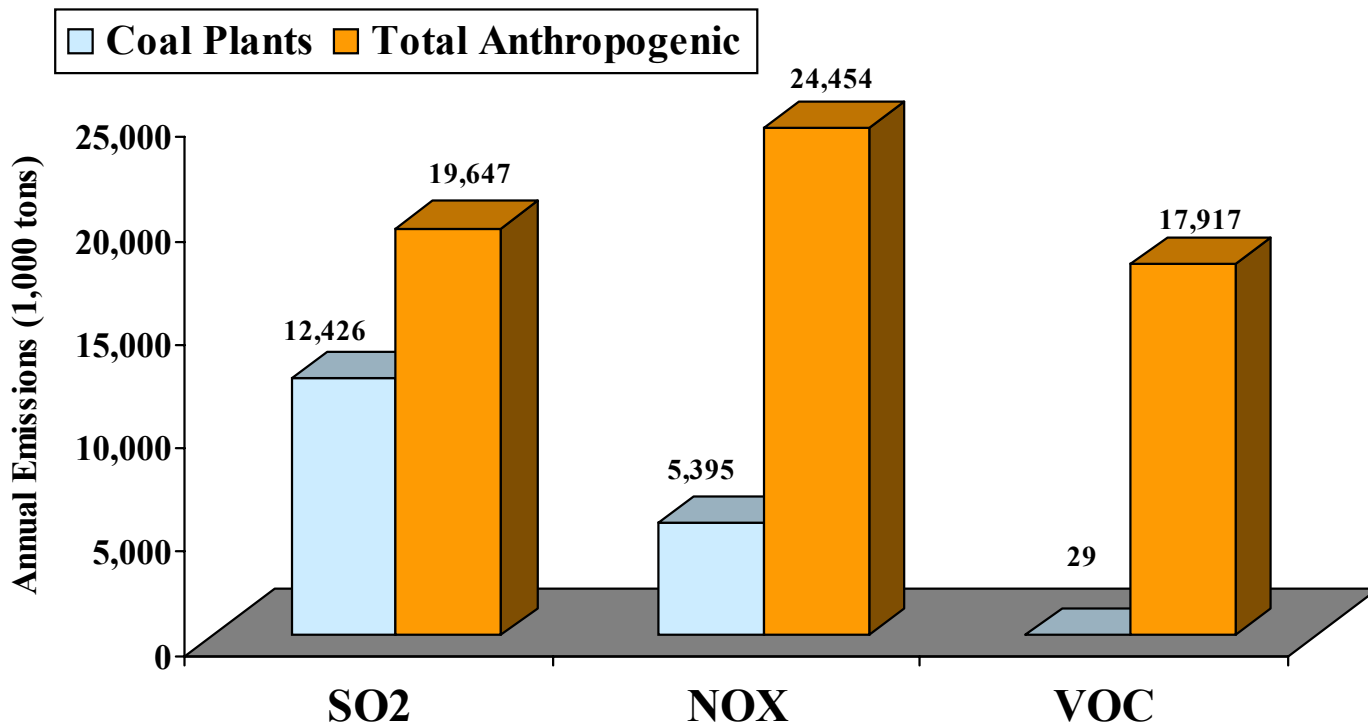
Ambient PM_{2.5} Chemical Speciation (*Winter 1999*)



**Rural Site
Holbrook, PA
(avg. of 9 samples)**



1998 U.S. Secondary PM_{2.5} Precursor Emissions



Source: *National Air Quality and Emissions Trends Report*, 1998 (EPA, 1999)

Coal Power & PM_{2.5} - Central Issues

- Power plant emissions contribute significantly to secondary PM_{2.5} mass
- Effect of power plant emission reductions on PM_{2.5} mass and regional haze is uncertain
- Effect of power plant emission reductions on human health is even less certain

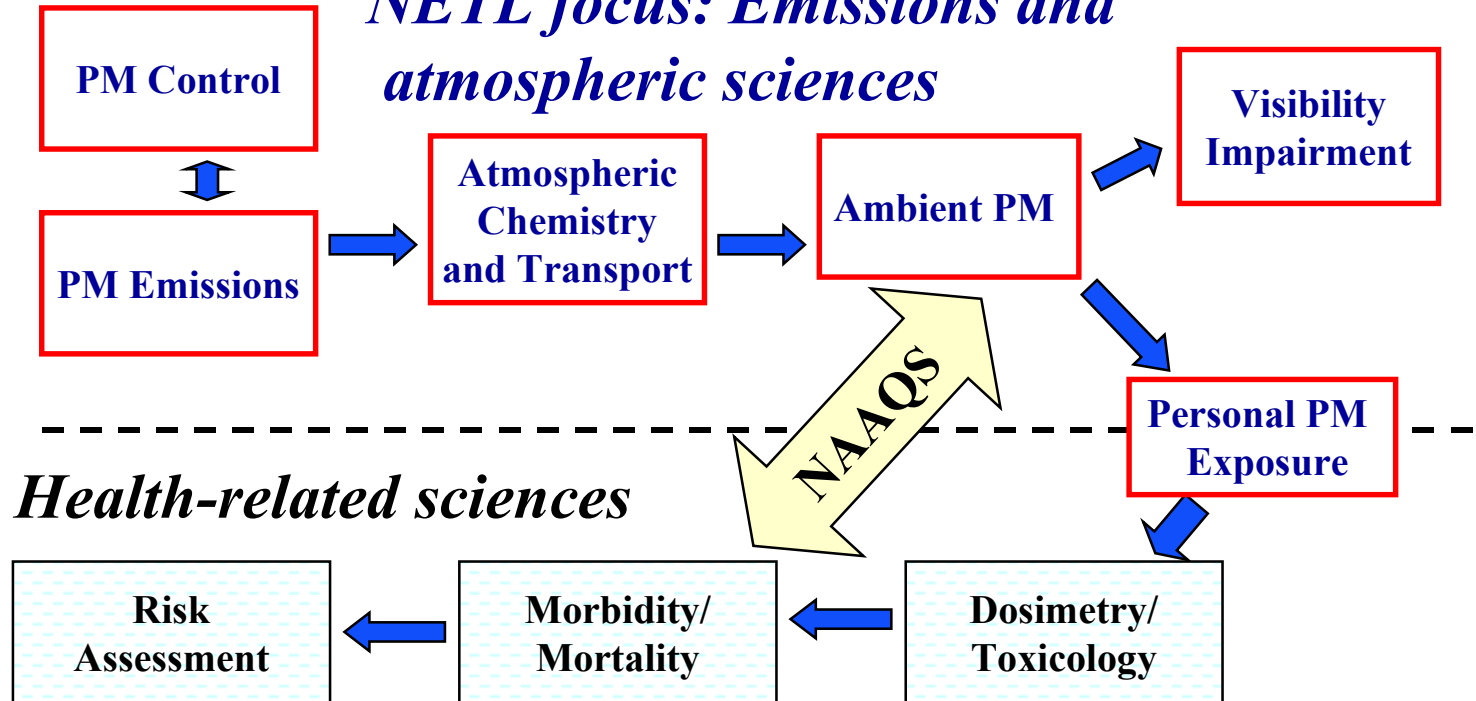
DOE-NETL PM_{2.5} Program Goals

- Relate emissions from coal-based energy production to concentrations and composition of ambient PM_{2.5}
- Inform decision-makers about energy management options for achieving PM_{2.5} and related air quality standards



PM-Related Research Areas

NETL focus: Emissions and atmospheric sciences



Program Components

- **Ambient Monitoring and Analysis**
- **Emissions and Plume Characterization**
- **Modeling and Evaluation**
- **Emissions Control Technology**



Ambient Monitoring and Analysis

DOE-NETL's Major Projects in PA-OH-WV



- **Steubenville Comprehensive Air Monitoring Project (SCAMP)**
- **Upper Ohio River Valley Project (UORVP)**
- **Pittsburgh Air Quality Study (CMU/EPA “Supersite”)**
- **NETL In-House Site**



SCAMP Outdoor Study

Description and Preliminary Results

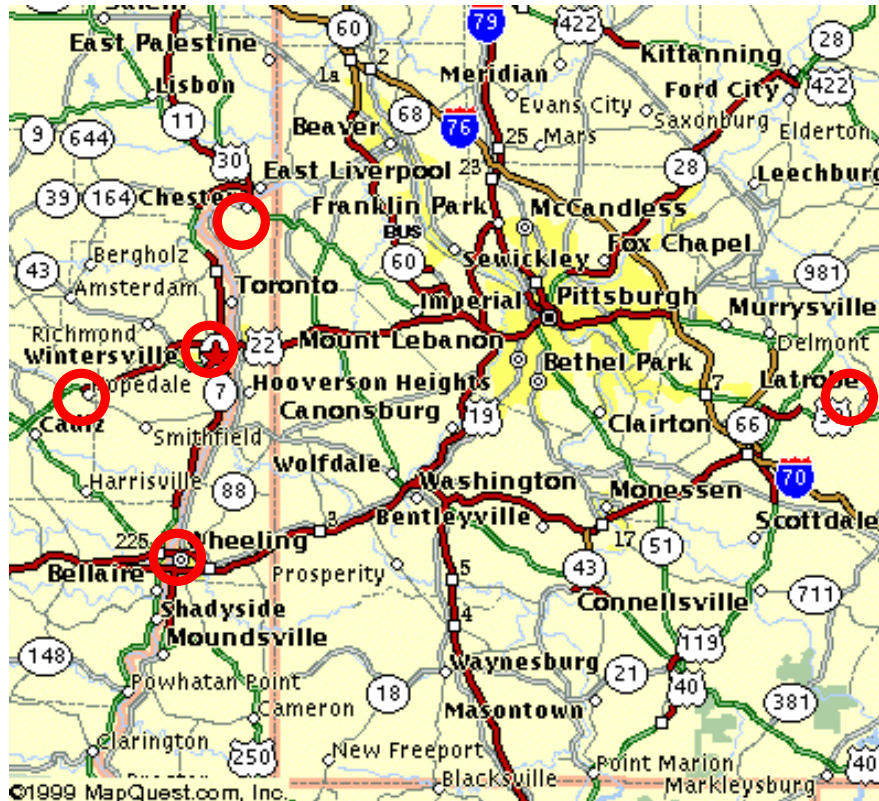


SCAMP Outdoor Study - Status

- **Sampling May 2000 - May 2002**
- **Ambient data analysis “complete” through Dec. 2000**
 - Performed by CONSOL, Inc.
- **Not yet integrated with Personal Exposure Study**



SCAMP- Ambient Monitoring Sites



- Steubenville, OH (Central Site)
- New Manchester, WV
- Hopedale, OH
- Wheeling, WV
- Latrobe, PA

SCAMP Outdoor Sampling Program

- **Central site**

- Daily filter sampling of PM_{2.5} and PM₁₀ mass
- 1 in 4 chemical analysis of PM_{2.5} filter samples
- Continuous sampling of PM_{2.5} mass (TEOM) and gases (CO, O₃, SO₂, NO_x, NMHC, CH₄, NH₃)
- Weather, pollen, mold spores

- **Satellite sites**

- Daily PM_{2.5} mass via filter sampling (FRM)
- 1 in 4 chemical analysis of PM_{2.5} filter samples



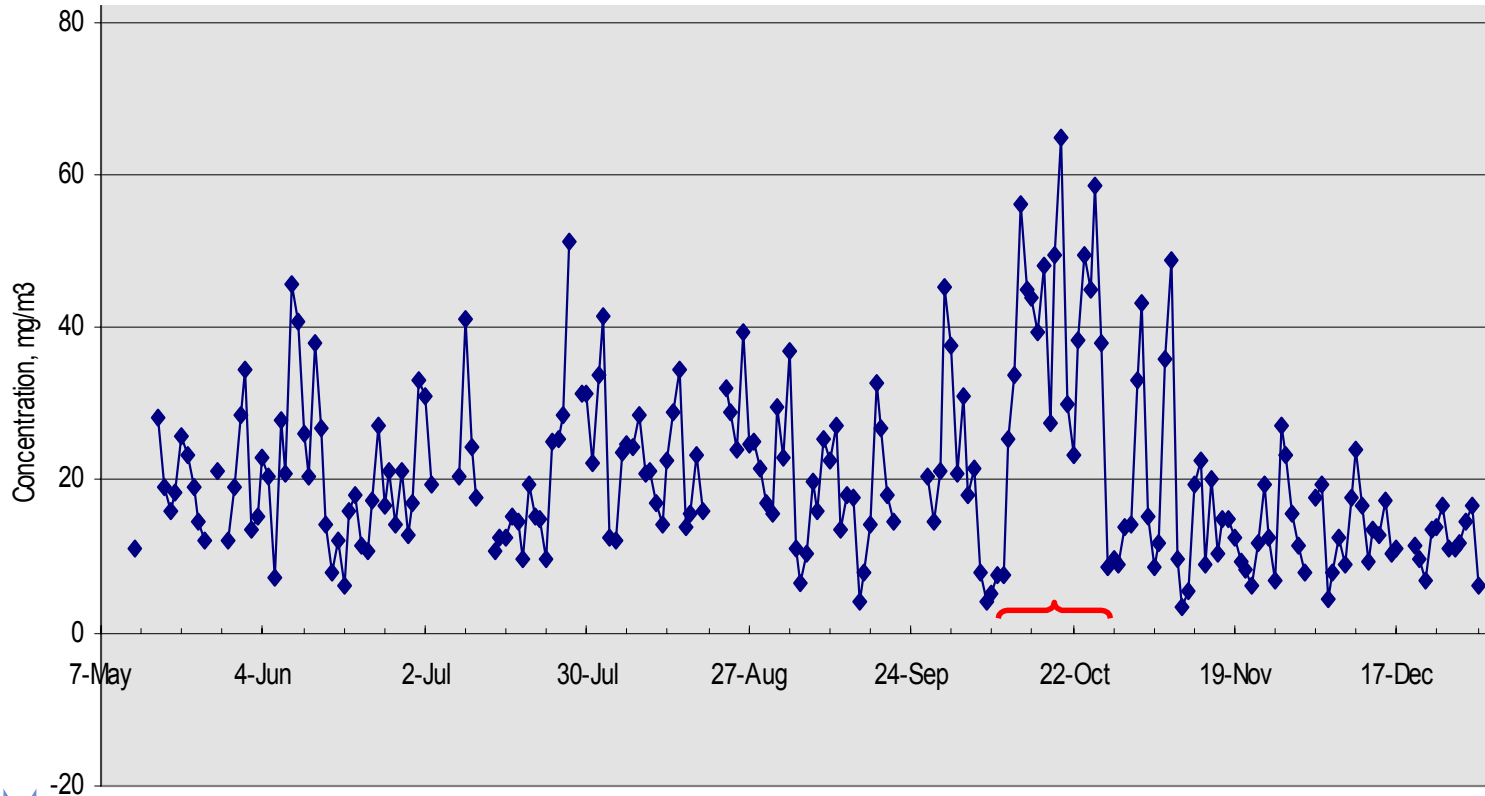
SCAMP Central Site

- Franciscan University of Steubenville

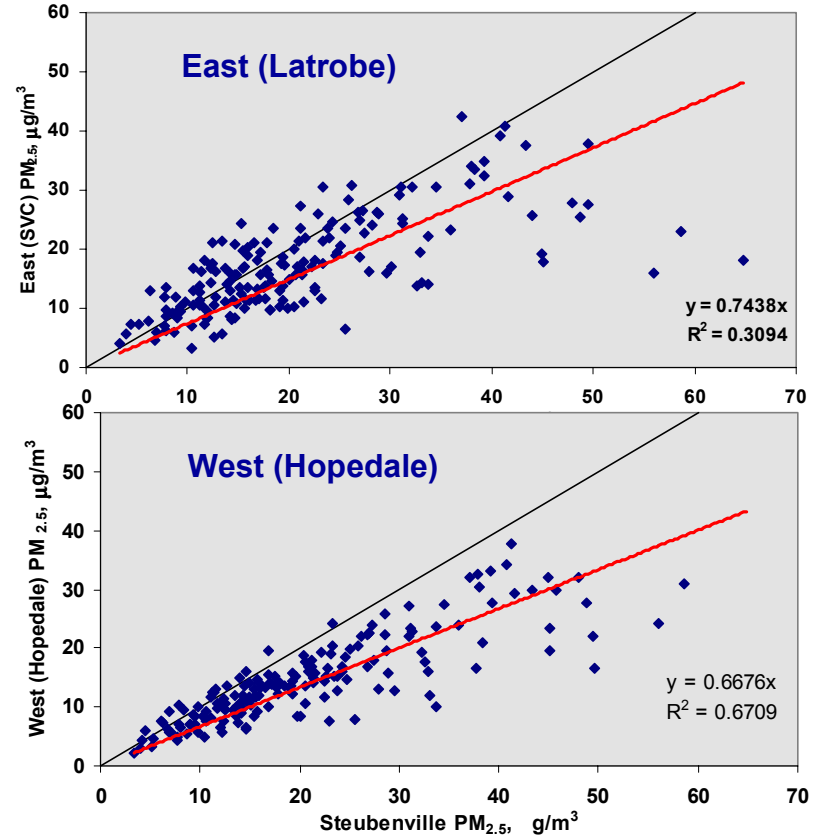
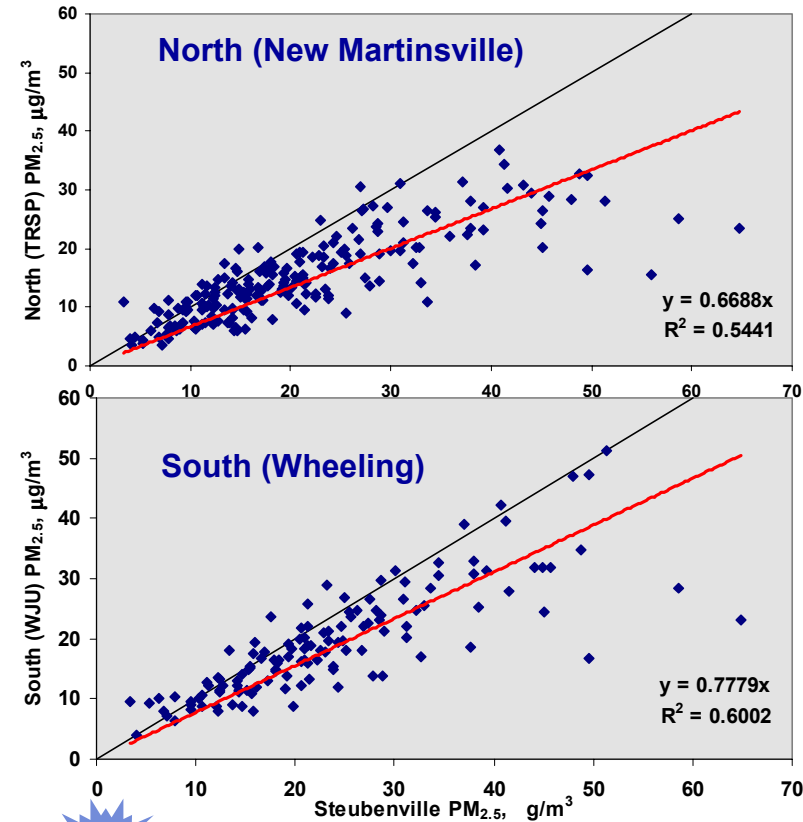


Steubenville PM_{2.5} Mass Concentrations

Daily Filter (FRM) Data



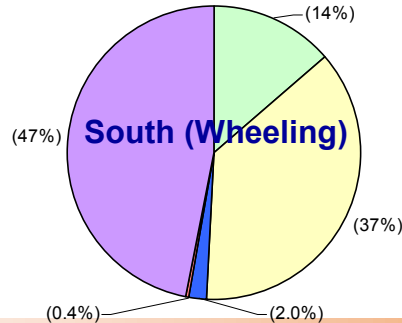
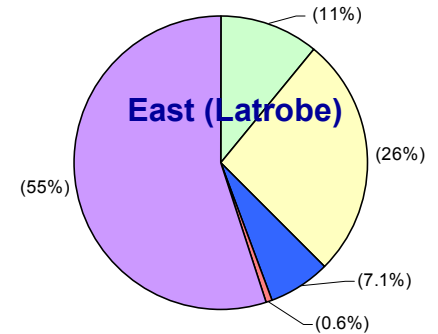
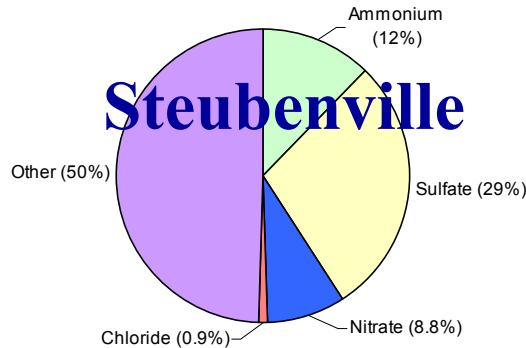
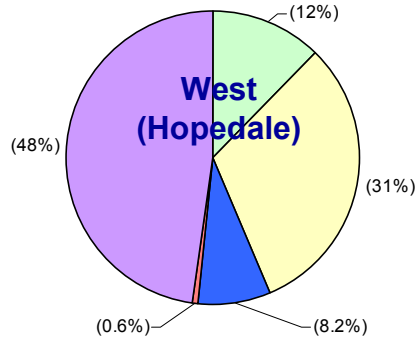
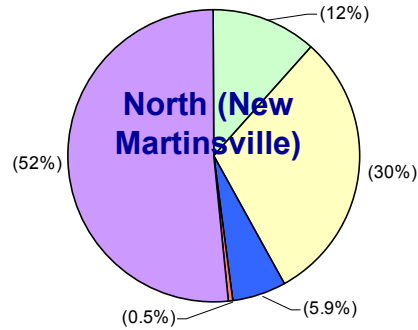
Steubenville PM_{2.5} Mass vs. Satellites



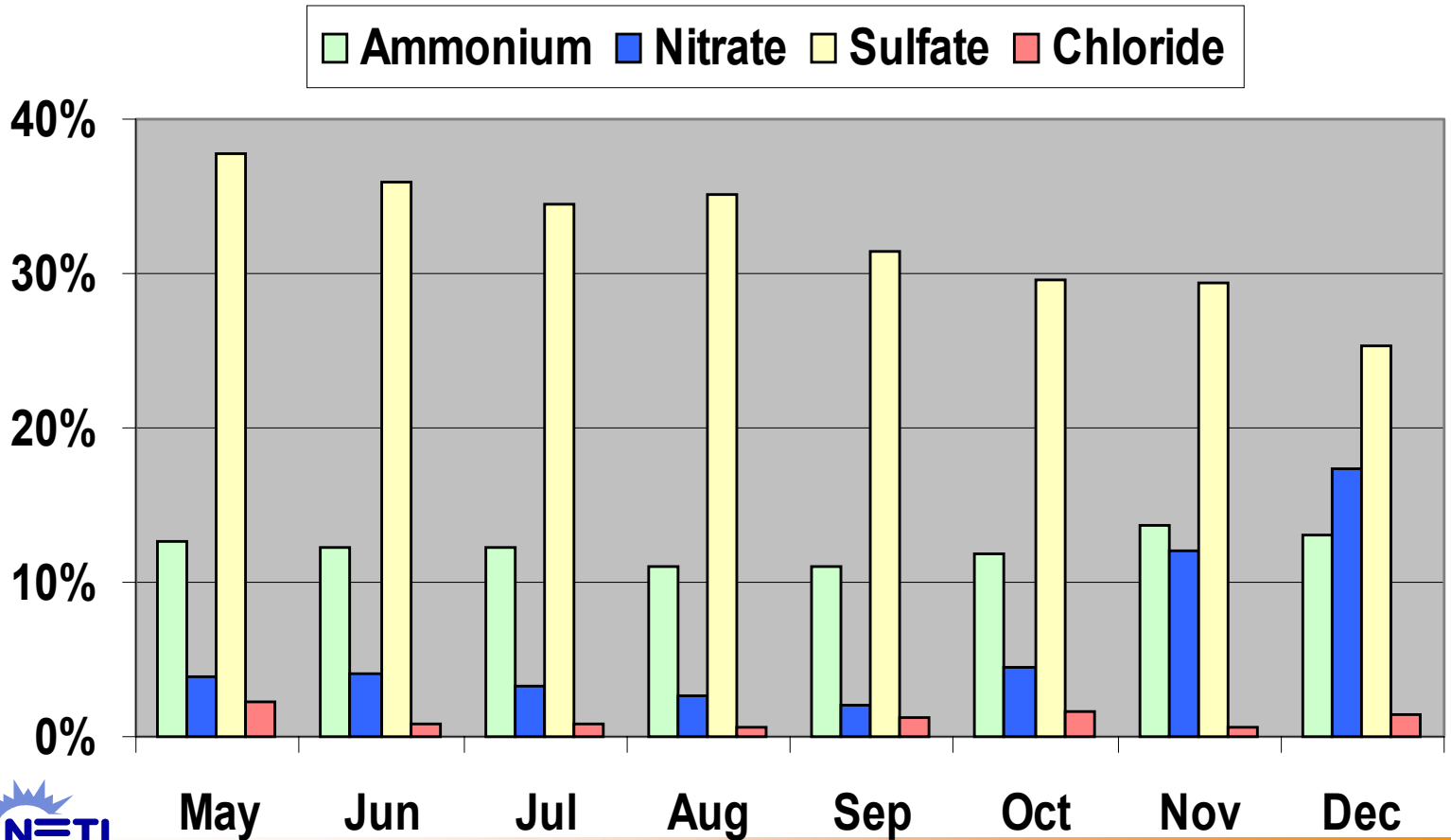
SCAMP - Average PM_{2.5} Mass (FRM)

		May through August	September through December	May through December
PM_{2.5}	Steubenville	21.5	20.0	20.7
	North (New Martinsville)	16.3	13.6	14.9
	South (Wheeling)	18.5	19.6	18.9
	East (Latrobe)	19.2	14.9	16.9
	West (Hopedale)	15.8	13.2	14.4
PM₁₀	Steubenville	29.1	26.4	27.7

Average PM_{2.5} Composition Sept.-Dec. 2000



Average Steubenville PM_{2.5} Composition, wt %



Average PM_{2.5} Composition, wt %

	NH ₄ ⁺		SO ₄ ²⁻		NO ₃ ⁻		Cl ⁻		Other (by difference)	
	May-Aug	Sep-Dec	May-Aug	Sep-Dec	May-Aug	Sep-Dec	May-Aug	Sep-Dec	May-Aug	Sep-Dec
Steubenville	12.0	12.2	35.7	28.6	3.3	8.8	0.9	0.9	48.1	49.5
North	11.7	11.7	36.4	30.2	2.1	5.9	1.2	0.5	48.6	51.6
South	13.1	13.7	39.7	37.1	2.7	2.0	0.8	0.4	43.7	46.8
East	11.9	10.9	35.8	26.5	2.6	7.1	1.0	0.6	48.7	55.0
West	12.3	12.3	38.1	31.3	2.5	8.2	1.0	0.6	46.1	47.6



Decrease



Increase

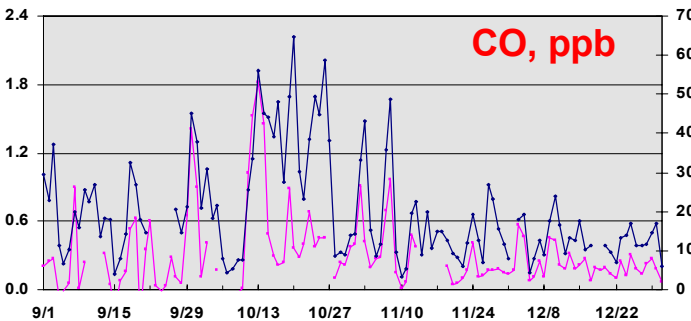
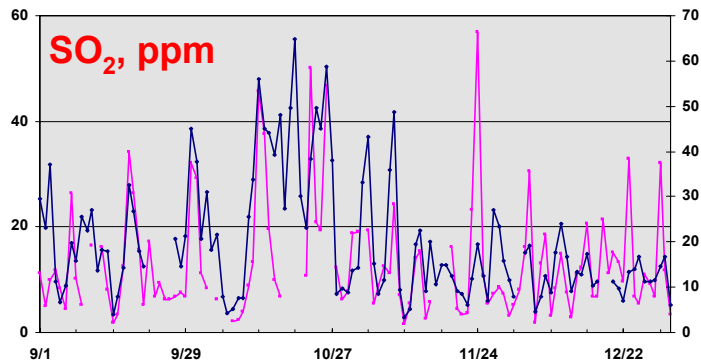
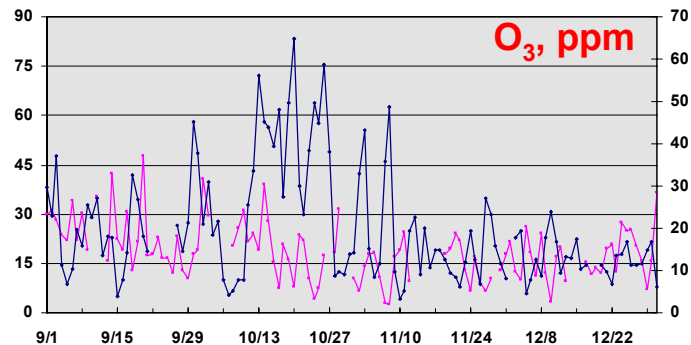
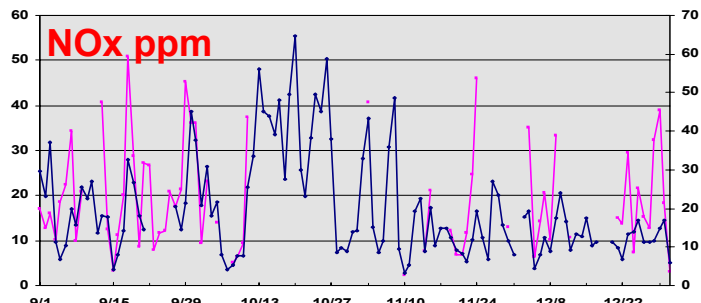


SCAMP Continuous Samplers (Central Site)

Sept-Dec. 2000

• Gases - pink

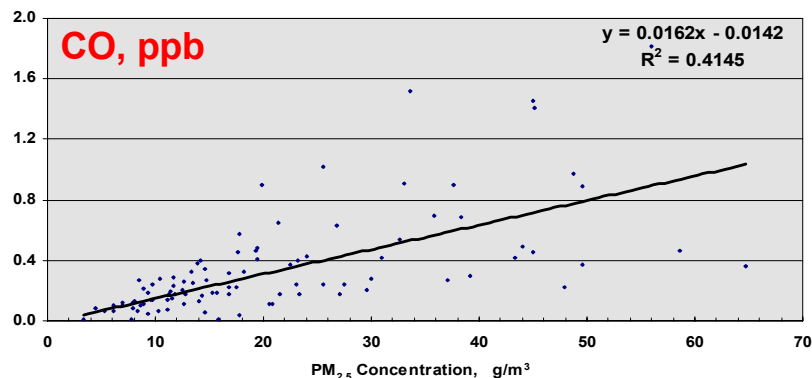
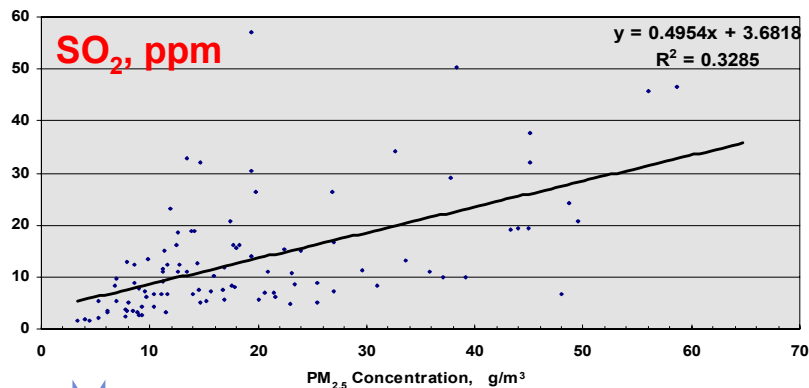
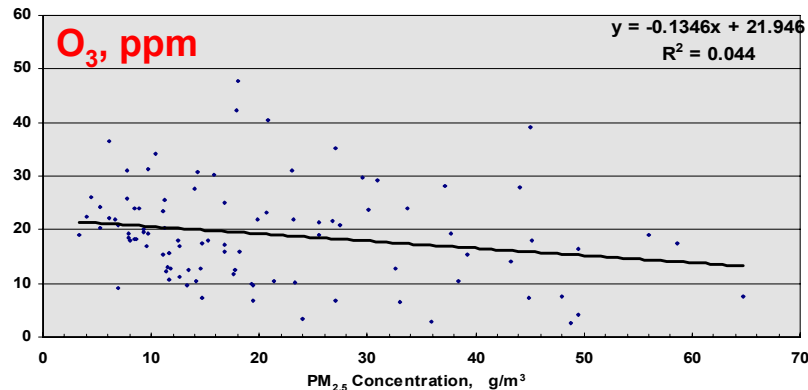
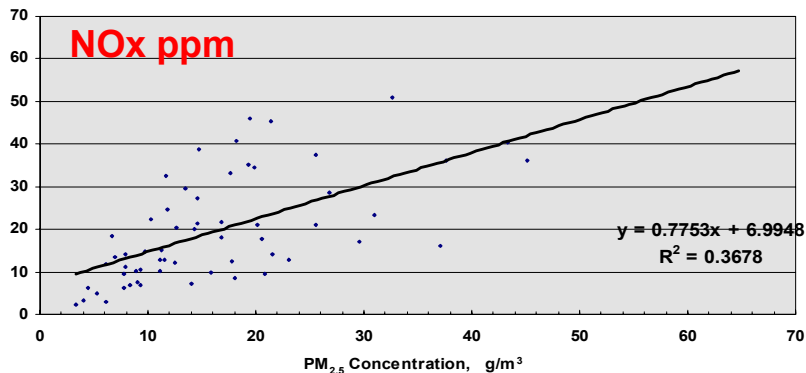
PM_{2.5} mass (TEOM) - blue



PM_{2.5} mass, $\mu\text{g}/\text{m}^3$

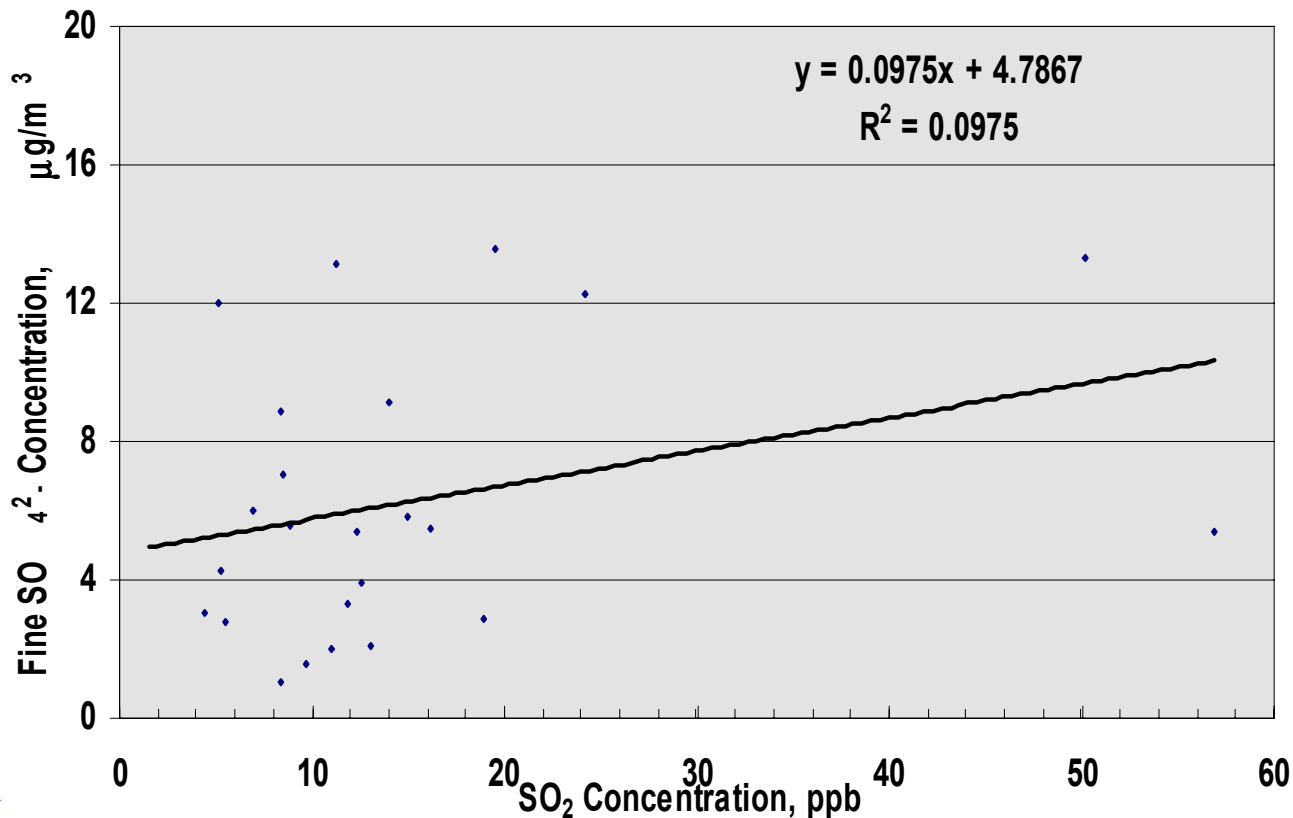
Gas Concentrations vs. PM_{2.5} TEOM Mass

SCAMP Central Site, Sept-Dec. 2000



SO₂ vs. PM_{2.5} Sulfate

SCAMP Central Site, Sept-Dec. 2000



PM_{2.5} vs. Weather Conditions

- **No significant correlation between PM_{2.5} and surface meteorological parameters (wind speed, direction, humidity, temperature, precip., etc.)**
- **Need to investigate effects of regional air mass movement**
 - Organize data according to common particle trajectories

Summary - SCAMP Outdoor Study

- High day-to-day variability in $\text{PM}_{2.5}$ concentrations
- All sites close to or above annual $\text{PM}_{2.5}$ standard
- $\text{PM}_{2.5}$ variations were consistent across all sites
- Sulfate fraction decreased and nitrate fraction increased from summer to winter 2000
- $\text{PM}_{2.5}$ concentration showed some correlation with the ambient air gases (except O_3)
- No strong correlation between $\text{PM}_{2.5}$ and weather data
- Pollen and mold spore concentrations were not correlated with $\text{PM}_{2.5}$



SCAMP Personal Exposure Study

Description and Preliminary Results



SCAMP Personal Exposure Study - Background

- **Studies have repeatedly shown positive associations between outdoor PM_{2.5} levels and increased mortality and morbidity**
 - Respiratory and cardiovascular problems
- **Questions remain regarding:**
 - How populations are exposed to air pollution
 - Components most responsible for health effects

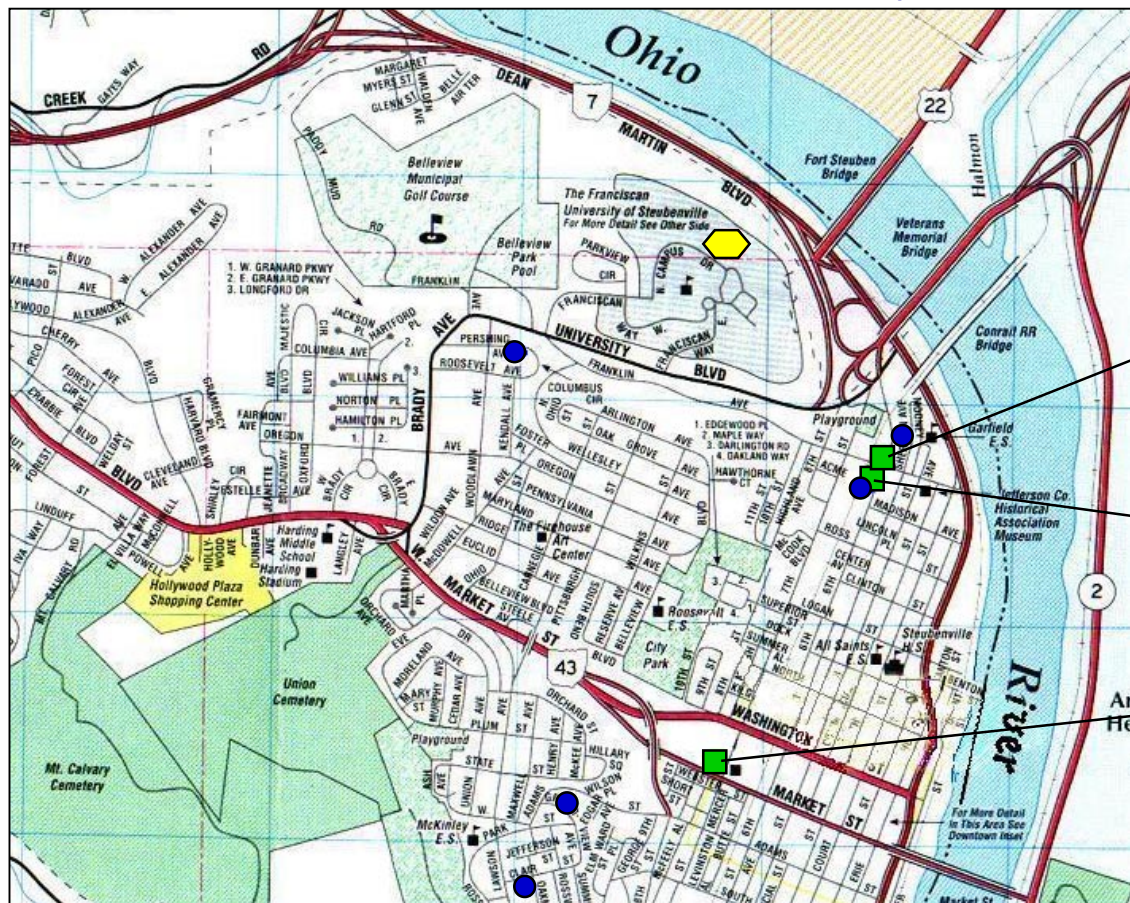


SCAMP Personal Exposure Study - Status

- **Completed data collection for panel studies of 2 “susceptible” populations**
- **Older Adults: Summer 2000; Fall 2000**
 - Companion cardiovascular health study (NIEHS)
- **Children: Winter 2001; Summer 2001**
- **Preliminary data analysis for older adult panel**
 - PM_{2.5} mass concentrations



Older Adult Panel Study Locations



- - Bldg 1,2,3
- - Houses
- ⬡ - Central site

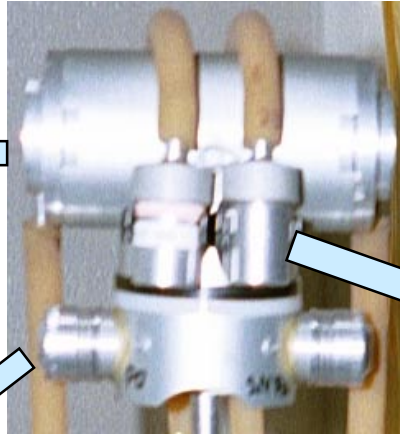
**Elmer
White**

Kennedy

Gaylord

Harvard Multi-pollutant Monitor

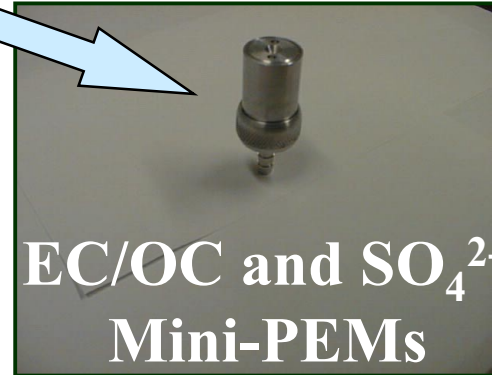
2x PM_{2.5} PEMs



- 24-hr filter samples

NO₂/SO₂ and O₃
Ogawa badges
(passive samplers)

EC/OC and SO₄²⁻
Mini-PEMs



Harvard Outdoor Sampling



Harvard Indoor/Personal Sampling

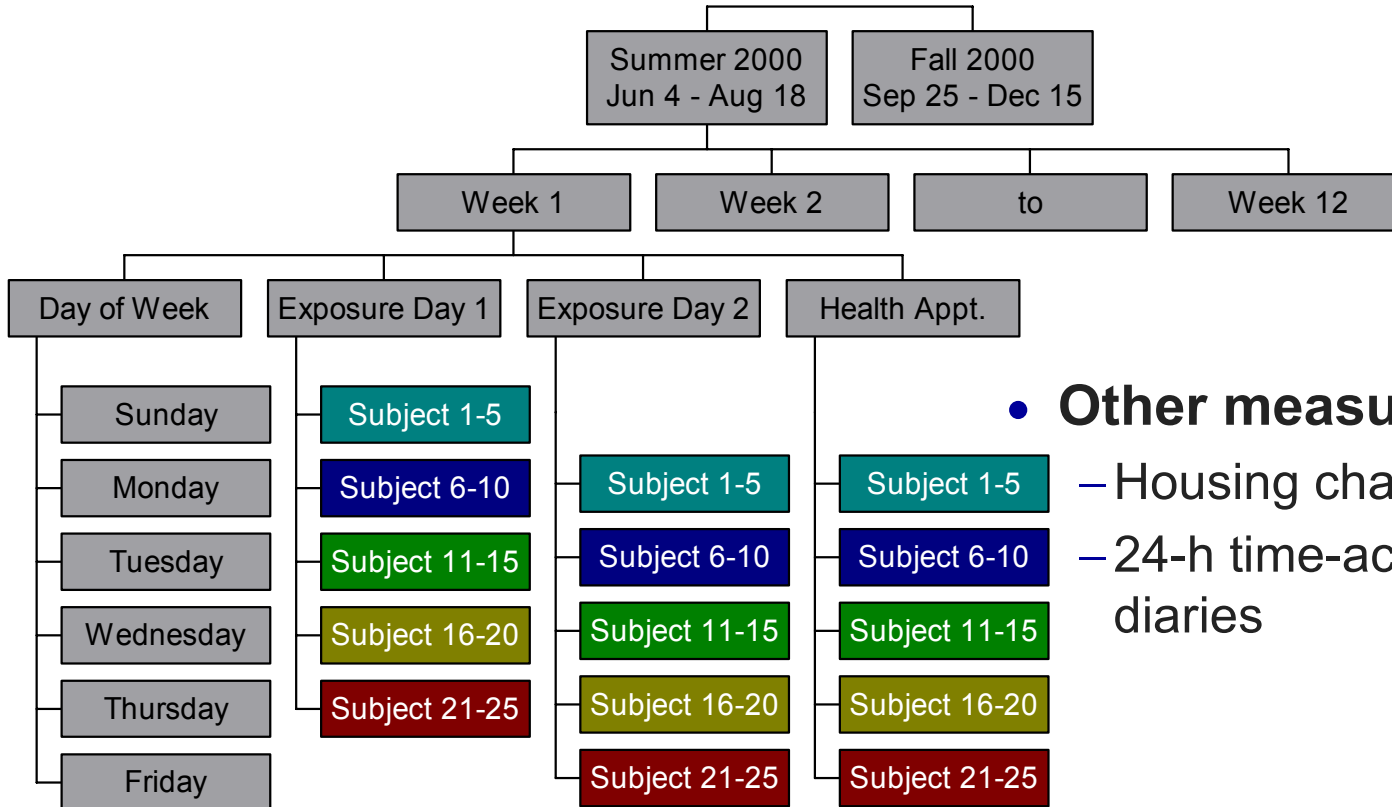


Personal Exposure/Health Study Participants

	Subjects	Gender	Age	Residence
Summer	30 Health 25 Indoor 10 Personal	28 Female 2 Male	71.6 (55-90)	Kennedy (15) Elmer White (4) Gaylord (5) Off Site (6)
Fall	29 Health 25 Indoor 10 Personal	27 Female 2 Male	70.7 (53-90)	Kennedy (13) Elmer White (5) Gaylord (5) Off Site (6)

- 32 different participants overall
- 27 reported heart/lung conditions
- No current smokers; 15 previous smokers

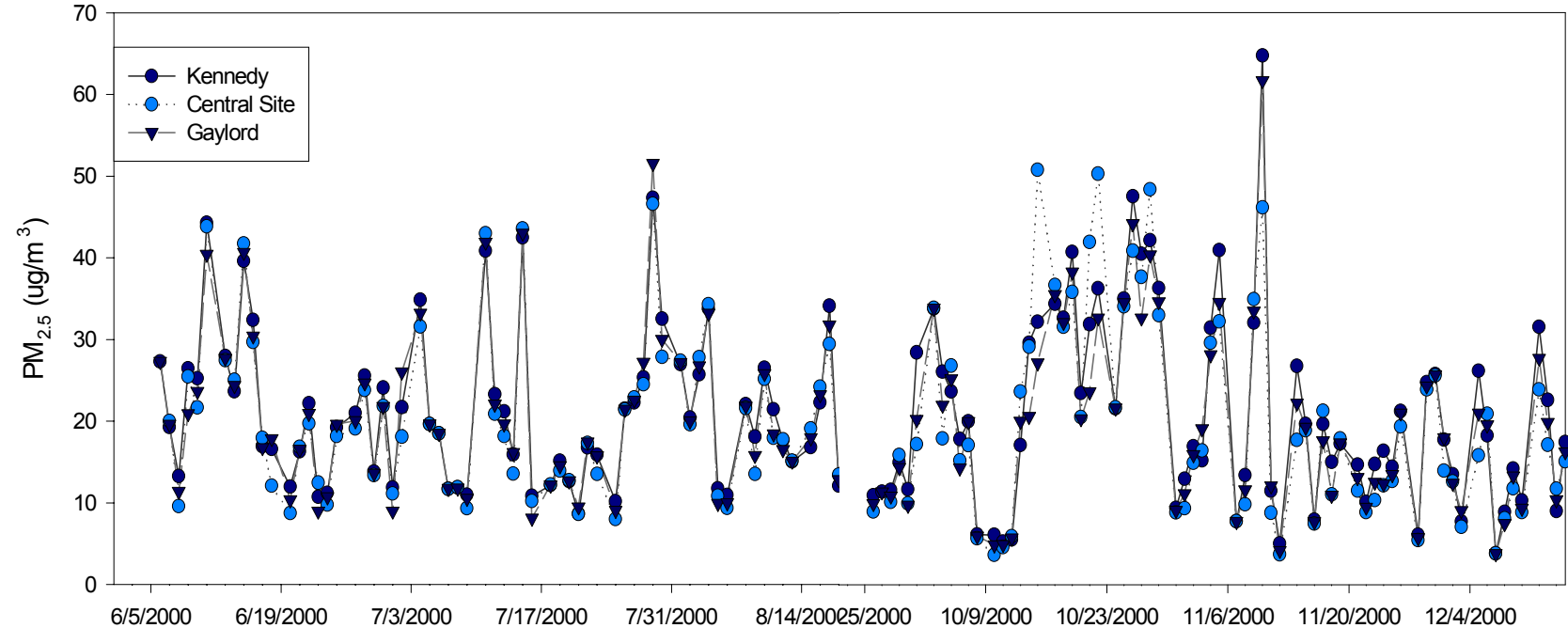
Personal Exposure/Health Sampling Schedule



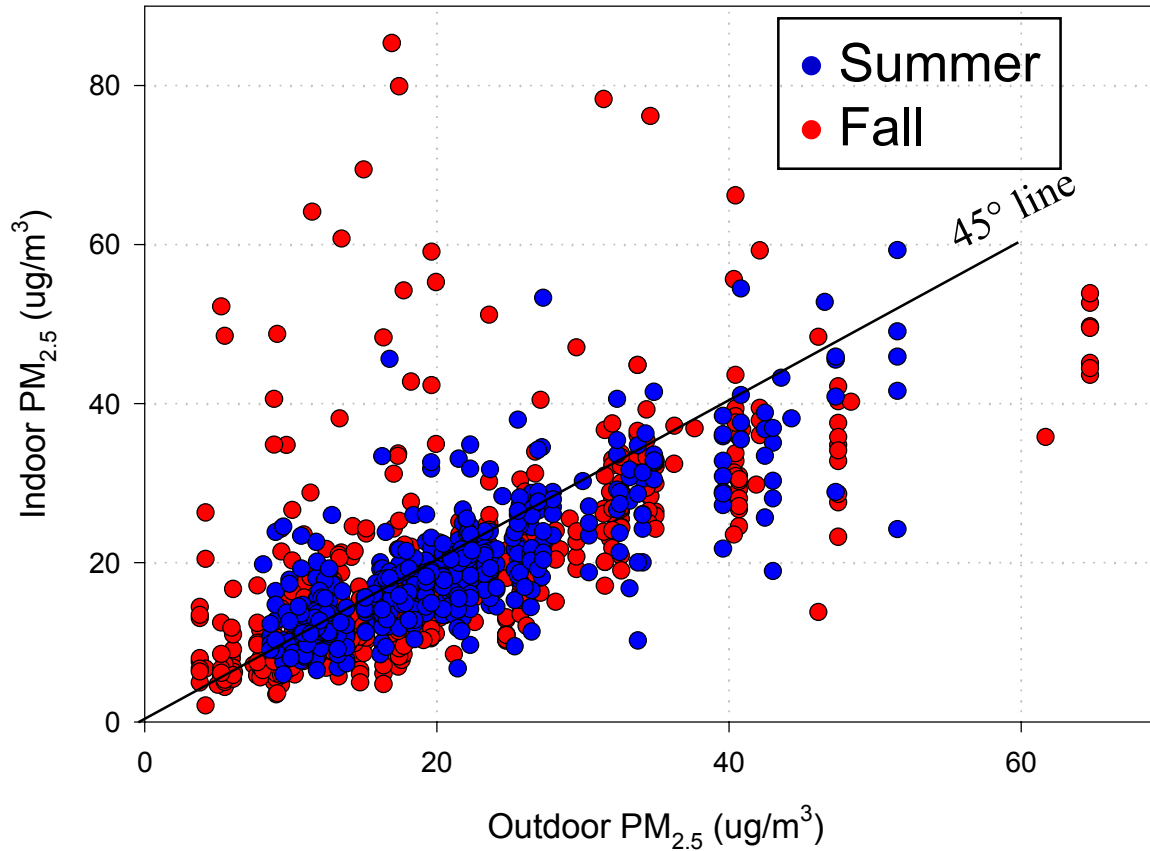
- **Other measurements**
 - Housing characteristics
 - 24-h time-activity diaries

PM_{2.5} at Outdoor Sites

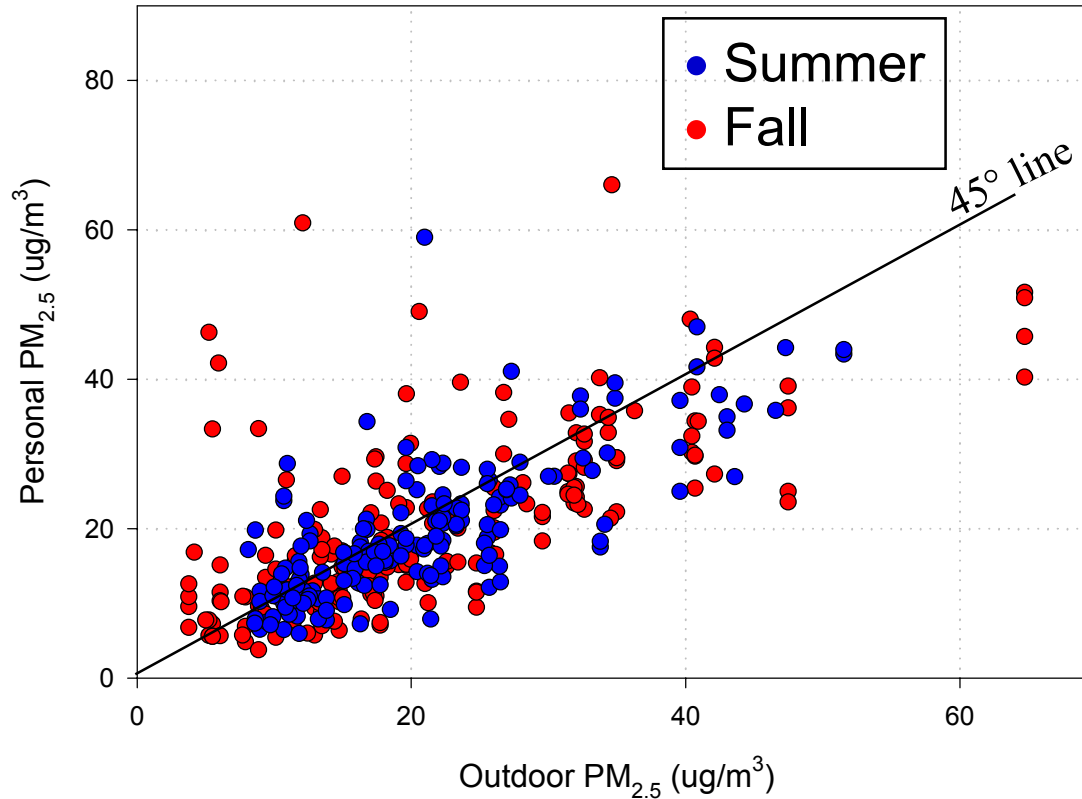
Harvard Personal Exposure Study



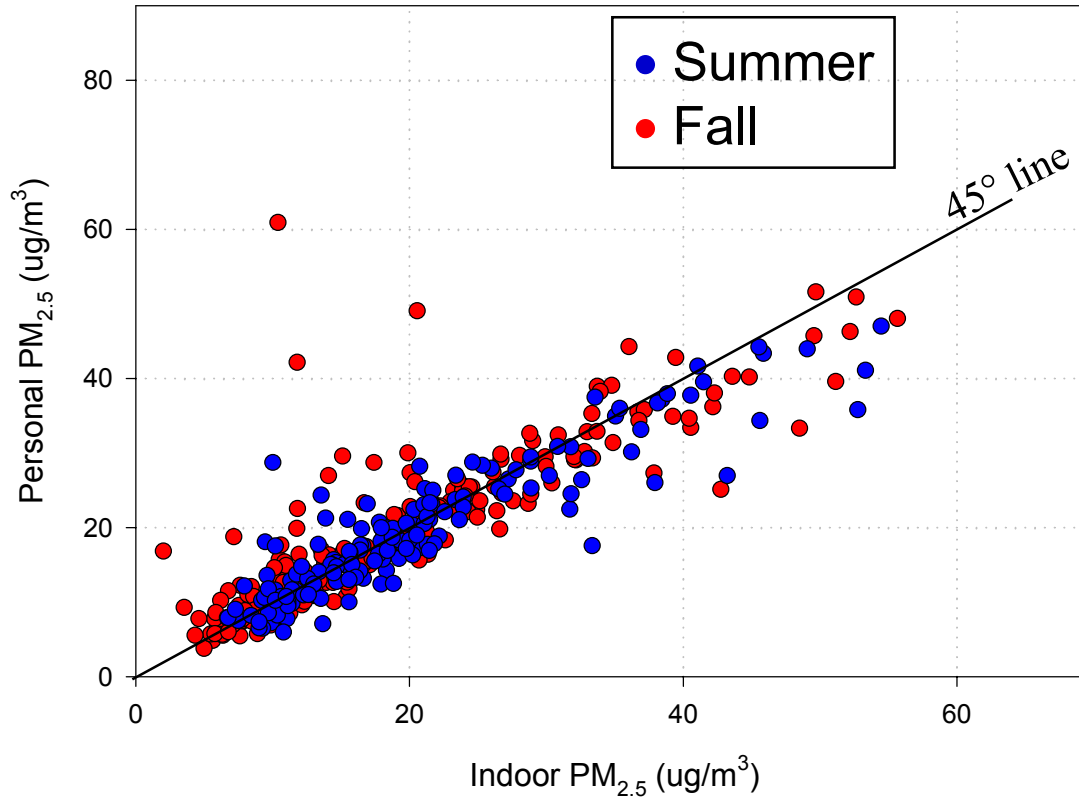
SCAMP Outdoor vs. Indoor PM_{2.5}



Outdoor vs. Personal PM_{2.5}



Indoor vs. Personal PM_{2.5}



Personal Exposure Study - Future Work

- **Assess correlation among personal, indoor and outdoor gaseous exposures**
- **Assess correlation among personal, indoor and outdoor PM_{2.5} composition**
- **Use mixed regression models to account for:**
 - Subject and season effects
 - Home ventilation and other activity factors
- **Use exposure measurements in analyses with the cardiovascular health measurements**

Acknowledgements

- **CONSOL, Inc.**
 - Steve Winter
 - Jeff Withum
- **Harvard School of Public Health**
 - Stefanie Ebelt
 - Petros Koutrakis

For Further Information on DOE-NETL PM_{2.5} Research Program

- **NETL Environmental & Water Resources Product Line Website:**
 - www.netl.doe.gov/coalpower/environment
- **Other Communications tools:**
 - 5-year Strategic Plan
 - Program Fact Sheet
- **NETL Conference - April 9-10, 2002**
 - *“PM_{2.5} and Electric Power Generation: Recent Findings and Implications”*

